Iatrogenic vascular lesions in extremely low birth weight and low birth weight neonates

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Purpose: **Aggressive treatment has improved the long-term outcome of extremely low birth weight (ELBW) and low birth weight (LBW) neonates, but it has also increased the risk of iatrogenic lesions. The aim of this paper is to evaluate the incidence of vascular injuries observed in the neonatal intensive care unit of our hospital.**

Methods: **From 1987 to 1994, 2898 neonates were admitted to the neonatal intensive care unit; 335 of them were either LBW or ELBW (11.5%). A review of the charts of these neonates disclosed nine neonates (four male, five female) with vascular lesions (2.6%); the mean gestational age of these patients was 28.7 weeks (range, 24 to 33 weeks), the mean weight at birth was 880 g (range, 590 to 1450 g), and the mean weight at diagnosis was 1825 g (range, 1230 to 2700 g). In the same period, 10 neonates with vascular injuries were reported in the 2563 neonates who weighed more than 1500 g (0.3%). The injuries observed in LBW and ELBW group were arteriovenous fistulas (two bilateral) at the femoral level (six neonates), carotid lesion (one neonate), and limb ischemia (two neonates). Injury was associated with venipuncture in seven neonates, and with umbilical catheter in one; the case of carotid lesion was related to surgical error. No general symptoms were observed.**

Results: **The carotid lesion and five arteriovenous fistulas were repaired by microsurgical techniques; one case of limb ischemia was resolved with thrombolytic drugs, whereas an amputation at the knee level was required in the other after 10 days of medical treatment. One neonate with an arteriovenous fistula was just observed according to the parents' wishes. At clinical and echo-color Doppler follow-up, seven of nine neonates had normal vascular function without sequelae.**

Conclusions: **In our experience, LBW and ELBW neonates are at greater risk than older neonates of the development of iatrogenic vascular lesions. We advocate aggressive microsurgery, medical treatment, or both to obtain good results and prevent late sequelae. (J Vasc Surg 1997;26:643-6.)**

Aggressive treatment in the neonatal intensive care unit (NICU) has improved the long-term outcome of extremely low birth weight (ELBW) and low birth weight (LBW) neonates, but it has also increased the risk of iatrogenic vascular lesions (arteriovenous fistulas, thromboses, aneurysms, gangrene) as a result of catheterization, repeated venipuncture, or arterial blood sampling.[1,2] These lesions require an accurate, noninvasive clinical diagnosis and prompt exploration and reconstruction using microvascular techniques.[2] To study these lesions and their outcome, we reviewed the charts of all neonates admitted to the NICU of the Department of Pediatrics of Padua over a 7-year period.

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MATERIAL AND METHODS

Patient data were obtained from hospital and office records, operative summaries, and photographs. From January 1, 1988, to December 31, 1995, 2898 neonates were admitted to our NICU; of these, 335 babies (11.5%) were ELBW (<1000 g) or LBW (<1500 g). We observed nine cases of vascular lesions (2.6%) in this group, consisting of arteriovenous fistulas (two bilateral) at femoral level (six

Table I. Characteristics of neonates

No.	*Sex*	*Birth weight (g)*	*Gestation (wk)*	*Weight at diagnosis (g)*	*Cause*	*Pathologic findings*	*Treatment*	*Follow-up*
1	M	1160	33	1800	Venipuncture	Right limb ischemic lesion	Medical	ECD
2	M	590	30	1300	Venipuncture	Bilateral femoral AVF	Surgery	ECD
3	M	1070	30	1230	Venipuncture	Left femoral AVF	—	Lost
4	F	1450	30	1800	Venipuncture	Right femoral AVF	Surgery	ECD
5	F	690	25	2070	Venipuncture	Bilateral femoral AVF	Surgery	ECD
6	F	850	28	1500	Venipuncture	Right femoral AVF	Surgery	ECD
7	F	640	24	1600	Venipuncture	Left femoral AVF	Surgery	ECD
8	F	1150	31	2700	Iatrogenic lesion	Right iatrogenic carotid lesion	Surgery	ECD
9	M	1020	28	1050	Umbilical catheter	Right limb ischemia	Medical + surgery	Knee amputation

AVF, Arteriovenous fistula; *ECD,* echocolor Doppler.

neonates), carotid lesion (one neonate), and limb ischemia (frank thrombosis; two neonates). The mean gestational age of these patients was 28.7 weeks (range, 24 to 33 weeks), the mean weight at birth was 880 g (range, 590 to 1450 g), and the mean weight at diagnosis was 1825 g (range, 1230 to 2700 g; Table I). The injury was associated with venipuncture in seven neonates and with umbilical catheter in one; the carotid lesion was a result of a surgical error in which the artery was mistaken for the vein. Incipient cardiac failure was observed in only one of our patients, whereas other general symptoms such as respiratory distress or cardiomegaly were never present. Arteriovenous fistulas presented bruit and thrill at the femoral level, and the diagnosis was confirmed by echo Doppler examination. The carotid lesion was observed directly, and limb ischemia presented with the classic signs: a pulseless, cold, and pale leg. In the same period, 10 vascular injuries were reported in the 2563 neonates greater than 1500 g (0.3%; Table II). Statistical analysis of the two groups showed that the relative risk of vascular lesions in the LBW and ELBW babies was 6.89 with a confidence interval of 2.82 to 16.82.

RESULTS

The carotid lesion and the five arteriovenous fistulas were repaired by microsurgical techniques. One case of limb ischemia required an amputation at the knee level after 10 days of treatment with urokinase (4400 U/kg/day); with this drug we were able to earn a few centimeters of vital tissue and thus maintain the knee joint. The other neonate with limb ischemia was successfully treated with urokinase as above. The sixth neonate with an arteriovenous fistula was just observed, as requested by the parents.

At clinical and echo Doppler follow-up, seven of nine neonates had normal vascular function without sequelae.

DISCUSSION

Iatrogenic vascular lesions have been described in the fetal period,[3] associated with cesarean section,[4] and also in newborns.[5,13] The first literature description underlined the number of definitive lost limbs and deaths in children.[5]

The most common vascular lesions described are arteriovenous fistulas,[2,3,14-17] limb ischemia,[5,10] pseudoaneurysms,[11,18,19] and thromboses.[7,9,10] Many maneuvers performed in the NICU can cause these lesions, such as repeated venipuncture, cardiac catheterization, arterial blood sampling, and umbilical or central vein catheterization. These lesions present signs and symptoms immediately, as in the case of limb ischemia or thrombosis, or belatedly, as in arteriovenous fistulas or pseudoaneurysms.[6,8,9]

However, regardless of the type of injury, these patients need a diagnosis and treatment as soon as possible. LBW and ELBW neonates are a growing group of patients that, in our experience and that of others, is at greater risk of having this iatrogenic complication because of the size of the vessels, the length of hospital stay, and the need for considerable intensive care, which entails, for example, multiple diagnostic and therapeutic maneuvers, repeated blood sampling, and parenteral nutrition. We found this disease present in such a high number probably because micromethods with blood sampling from the foot have only recently been used regularly in our NICU; the past procedure was blood sampling from the femoral vessels. The incidence of iatrogenic lesions in our LBW and ELBW group was 2.6% compared with 0.3% in the population that weighed greater than 1500 g, with a relative risk of 6.89.

Table II. Characteristics of patients more than 1500 g

No.	*Sex*	*Birth weight (g)*	*Gestation (wk)*	*Cause*	*Pathologic findings*	*Treatment*	*Follow-up*
1	F	3250	38	Catheter	Right limb ischemic lesion	Medical + Fogarty catheter	ECD
2	F	3630	38	Catheter	Right limb ischemic lesion	Fogarty catheter	ECD
3	F	2800	37	Catheter	Right limb ischemic lesion	Medical + Fogarty catheter	ECD
4	F	3160	37	Catheter	Right limb ischemic lesion	Medical	ECD
5	M	3250	38	Venipuncture	Right limb ischemic lesion	Medical	ECD
6	F	1580	31	Venipuncture	Left femoral AVF	Surgery	ECD
7	F	2870	37	Catheter	Right limb ischemic lesion	Medical	ECD
8	F	1800	31	Venipuncture	Left femoral AVF	Surgery	ECD
9	M	1880	34	Venipuncture	Right limb ischemic lesion	Medical	ECD
10	M	2750	38	Radial artery puncture	Left radial pseudoaneurysm	Surgery	ECD

AVF, arteriovenous fistula; *ECD,* echocolor Doppler

The physical signs that suggest vascular compromise may be elusive,[1] and symptoms such as mottling, blue discoloration, blanching, poor capillary refilling, coolness, poor pulses, bruit, and thrill require particular attention.[1] These signs may be transient, but occasionally they may progress, for example to frank gangrene with a demarcation line.[1]

In planning the care of LBW and ELBW neonates, the first rule is to avoid unnecessary harm; if a vascular lesion is suspected, it should be promptly diagnosed and an aggressive medical or surgical treatment must be initiated.[2,13] Although the validity of ultrasonic methods is well documented for diagnosis in adults, these procedures are still under evaluation in pediatric age groups; preliminary results, however, are encouraging, and the diagnostic characteristics of arteriovenous fistulas are already described.[17,19]

The decision for medical or surgical treatment depends on the type of the lesion. In the case of thrombosis, most workers prefer to use drugs, such as heparin, urokinase, or streptokinase. The newborn infant appears to require a proportionately larger amount of heparin than an adult, and it seems difficult to maintain a therapeutic level of this drug. Thrombolytic agents have been shown to be effective and safe, and they are recognized as the first-choice therapy for thromboses.[1,10,12,13] In our experience as well, thrombolytic drugs are easily managed with good results.[9,10,13] We have used these drugs with success for catheter-related thromboses and venous and arterial thromboses for various time periods without complications. When should one decide to change from medical to surgical treatment in frank thromboses? We always start with thrombolytic drugs, and if no complications arise we continue for 48 hours; then, if clinical examination or imaging procedures show no improvement, surgery is performed.

Surgical treatment can be performed in the NICU or operating room depending on the baby's weight and clinical situation.[1,2] We prefer the operating room, but if the baby is too small and the neonatologist fears thermic insult we operate in the NICU. All the maneuvers must be performed with the magnification loupe or operating microscope; possible vascular spasm is controlled by topical application of 2% lidocaine or papaverine. In the case of arteriovenous fistula, pseudoaneurysm, and intimal dissection, surgery is mandatory to resolve the immediate problem, but also to avoid long-term sequelae, such as different limb length and size.

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